PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of:		)
APPLICANTS:	HASSAN TAHERI, CURTIS D. DICKINSON, AND PAUL A. JACOBSON	) Customer) No. 54,812
SERIAL NO:	09/920,981	) Group Art Unit:) 1764
FILED:	August 2, 2001	) Examiner:) Kevin P. Kerns
FOR:	FLOW REACTORS FOR CHEMICAL CONVERSIONS WITH HETEROGENOUS CATALYSTS	) Attorney Docket) No.: 39,000

AFFIDAVIT UNDER 37 CFR § 1.132

Commissioner for Patents
P. O. Box 1450
Alexandria VA 22313-1450

Primary Examiner Kerns:

This Affidavit is submitted in combination with a Request for Continued Examination. The outstanding FINAL Office Action in the above-identified application was mailed May 9, 2005, with a shortened statutory period for response of three (3) months, set to expire August 9, 2005.

AFFIDAVIT UNDER 37 CFR § 1.132
of Dr. HASSAN TAHERI

1. I, HASSAN TAHERI being duly sworn, depose and say:

2. That I reside at 229 south Sleight Street, Naperville, Illinois 60540.

3. In 1969 I received a Bachelor of Science degree in Chemical Engineering from the Texas A & M University, College Station, Texas, USA.

4. I received a Master of Science degree in Chemical Engineering in 1972 from Princeton University, Princeton, New Jersey, USA, and in May, 1975 a Doctor of Philosophy Chemical Engineering also from Princeton University. My dissertation research was a study of hydrogenolysis and isomerization of n-pentane over copper-nickel catalyst.

5. From July 1975 to the present, I have been employed by BP America Inc. and BP Chemicals, corporations of the State of Delaware, and have the position of Associate Research Engineer.

6. I am one inventor of the claimed subject matter of the above identified patent application.

7. I have read the Office Action from Examiner Kerns, mailed May 9, 2005, for our application and the references relied upon to reject our claims. I wish to respond to the rejections of Examiner Kerns.

8. In rejecting Claim 1, Examiner relies upon German Patent Number: 29 29 300 in the name of Linde AG as teaching Applicants' novel process except for the limitation that "the

diameter of a channel zone cubed is equal to the volume of that zone multiplied by a factor" more particularly a geometric factor which Applicants define to have values in a ranger from about 0.01 to about 0.50 (Office Action, second paragraph page 3). I respectfully submit that the Examiner's statement failed to identify critical elements of DE 29 29 300 teachings that are contrary to Applicants' novel invention.

9. The Linde AG reference of record describes three catalytic reactors characterized by the fact that the cross-section of the catalyst-containing pipes are varied along the direction of flow for three zones in Figures 2 and 3; and four zones in Figure 1. However, in none of these figures relied upon by Examiner do each and every downstream zone have a larger cross-section than the contiguous upstream zone.

10. By contrast our novel flow reactors comprises, as now recited in new Claim 35, a sequence of catalyst-containing zones comprising at least four catalyst-containing zones such that each downstream catalyst-containing zone has a larger cross-section than the contiguous upstream catalyst-containing zone, and wherein at least three of the downstream catalyst-containing zones has a larger volume than the contiguous upstream catalyst-containing zone.

11. I wish to present experimental examples that were carried out by me and/or under my direct supervision which reveal effects of the differences between our novel apparatus illustrated, for example, in Figure 2 of our application, and the Linde apparatus illustrated in Figures 1, 2, and 3 of German Patent Number: 29 29 300.

12. My experimental examples employed a mock-up of commercial flow reactor containing a fixed heterogeneous catalyst for continuous vapor-phase oxidation of n-butane with air. The mock-up

system included a 4.6-meter reactor tube which was immersed in a heat transfer medium comprising molten salt. The reactor tube was equipped with an axial thermowell which allowed determination of the temperature profile of the catalyst bed along the axial co-ordinate. In each example a suitable amount of fresh commercial catalyst, i.e., a vanadium-phosphorus-molybdenum-oxygen catalyst was charged to the reactor tube.

13. In this comparative example the test program was used to evaluate a cylindrical reference reactor having a uniform ID of 1 in. in a plane perpendicular to the centerline and a catalyst zone of about 2,102 cm^3. Concentration of butane in the feed was 1.7 mole percent. At 2000 VHSV in the catalyst zone and a molten salt temperature of 413° C. The temperature profile of the catalyst bed along the axial co-ordinate exhibited a maximum of 491° C. which is 78 degrees higher than the molten salt temperature.

14. The maleic anhydride yield was only 77 percent by weight, using a single cylindrical zone for catalyst which had a uniform cross-section.

15. In this example, my reactor tube had a volume for catalyst of about 2,158 cm^3 distributed according to our novel invention into four contiguous cylindrical zones, for example as shown in Figure 2 of our application, and characterized in Table A presented herewith as EXHIBIT A.

16. Concentration of butane in the feed was 1.7 mole percent. At 2000 VHSV in the catalyst zone and a molten salt temperature of 396° C. The temperature profile of the catalyst bed exhibited a maximum of 429° C. which is only 33 degrees higher than the molten salt temperature.

17. After the catalyst was fully activated, the maleic anhydride yield was 96 percent by weight for catalyst zones distributed according to our novel invention.

18. I conducted another comparative example which illustrates that, in contrast to the position of Examiner, flow reactors according to our novel invention provided unexpected and unpredictable better results, including both higher maleic anhydride yield and control of temperature profiles in the catalyst bed, and exhibited lower maximum temperature difference between catalyst and molten salt bath.

19. My second comparative example tested a reactor tube in which a volume of catalyst of about of about 617 cm^3 was distributed into four contiguous cylindrical zones as shown in Figure 1 of the Linde AG reference of record, and characterized in Table B presented herewith as EXHIBIT B.

20. Concentration of butane in the feed was 1.5 mole percent. At 2000 VHSV in the catalyst zone and a molten salt temperature of 384° C. The temperature profile of the catalyst bed exhibited a maximum of 471° C. which is 87 degrees higher than the molten salt temperature.

21. This increase of maximum temperature difference between catalyst and molten salt bath, more than two and one half times, contributed to the undesirable lower yields of the maleic anhydride which I observed using four contiguous cylindrical zones as shown in Figure 1 of the Linde AG reference of record and relied upon by Examiner Kerns.

22. In part because of the higher maximum temperature in the catalyst bed, the maleic anhydride yield was at best only 79 percent by weight. Within normal experimental variations, a reactor catalyst bed using four contiguous cylindrical zones as shown in Figure 1 of the

Linde AG reference of record, provided no better results than the 77 percent I observed using the cylindrical reference reactor having a uniform ID of 1 in.

23. It is my professional opinion that the foregoing experiments and observations demonstrate my finding that in flow reactors according to the invention, where the cross-section of the conduits in each catalyst-containing zone have a substantially circular form, having diameter such that the third power of the diameter is equal to the product of the volume of each conduit in the zone and a geometric factor having values in a ranger from about 0.01 to about 0.50 is critical to effect both higher maleic anhydride yield and control of maximum temperature difference between catalyst and molten salt bath.

24. In particular, I have obtained results demonstrating a preferred embodiment of Applicants novel flow reactors having four zones with geometric factors of 0.269, 0.227, 0.277 and 0.749, the maleic anhydride yield was 96 percent by weight and a maximum of catalyst which is only 33 degrees higher than the molten salt temperature. These results have been neither disclosed nor suggested by any references of record alone or in the combinations of Examiner.

25. By contrast, a reactor catalyst bed using four contiguous cylindrical zones as shown in Figure 1 of the Linde AG reference of record, provided no better results than the 77 percent I observed using the cylindrical reference reactor having a uniform ID of 1 in.

AND FURTHER AFFIANT SAYETH NOT.

HASSAN TAHERI

STATE OF ILLINOIS)
) SS.
COUNTY OF)

Sworn to and subscribed before me, a Notary Public, by said HASSAN TAHERI, on this 19th day of October 2005.

OFFICIAL SEAL
DIANNE J PEGRAM
NOTARY PUBLIC - STATE OF ILLINOIS
MY COMMISSION EXPIRES:06/25/08

(SEAL)

Notary Public

CUSTOMER NO. ~~04249~~ 54,812

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EXHIBIT A HASSAN TAHERI AFFIDAVIT UNDER RULE 1.132

Table A

Catalyst Zone & ID, in.	Fraction of Axial Length	Percent of Total Catalyst Volume	Geometric Factor x 10^2
I 0.81	0.2486	15.75	2.69
II 0.87	0.3094	22.02	2.27
III 1.12	0.3094	38.16	2.77
VI 1.33	0.1326	24.07	7.49

EXHIBIT B HASSAN TAHERI AFFIDAVIT UNDER RULE 1.132

Table B

Catalyst Zone & ID, in.	Fraction of Axial Length	Percent of Total Catalyst Volume	Geometric Factor x 10^2
I 0.98	0.1250	12.07	20.83
II 0.87	0.3125	23.67	7.39
III 0.98	0.2292	22.11	11.37
VI 1.12	0.3333	42.15	8.94

Concentration of butane in the feed was 1.5 mole percent. At 2000